Report of Investigation

Analysis of the 2005 BLM Monitoring Database

May 18, 2006

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The dataset collected during the 2005 monitoring survey was delivered to the Carlsbad Fish and Wildlife Office on February 10, 2006. The data was delivered in a geodatabase in Microsoft Access format and included information on *Helianthus niveus var. tephrodes* (Algodones Dunes sunflower). Milk-vetch data was separated from the Algodones Dunes sunflower data for analysis. We added two new attribute fields to the data to facilitate comparison between areas open to OHV activity and those currently closed to OHV activity. This latter category includes the North Algodones Wilderness and four temporary closures established in 2001. One new field identifys sample cells in the closed areas and the second new field categorizes abundance classes for each cell. Because there is an apparent north-to-south gradient in plant density, abundance classes were relative to each management area. A frequency of plant abundance was calculated for each management area and then binned into seven abundance classes each containing an equal number of frequency classes. We assumed the fourth or middle class would approximate the mean plant density calculated in the 2005 monitoring report for each management area. Additional baseline statistics were also derived from the data for number and percentage of occupied cells by management area and closure status.

To test for expected presence of PMV within areas closed to OHV activity, we conducted two Chi-square tests on the data. The first Chi-square test selected 5% of the data, beginning at a random start point and selecting every 31st and 51st record for a total of 6,327 records or 5.1% of the total 123,488 records. The second Chi-square test selected 1% of the data by selecting every 191st and 211th record for a total of 1,228 records (0.99%). We then used Fisher's Exact Test to report an odds ratio.

Results of Our Analysis

Milk-vetch plants were found in cells open to OHV activity as well as in cells closed to OHV activity. However, occupied cells were not randomly distributed among the surveyed cells in the seven management areas. Of the total 123,488 cells surveyed during the 2005 monitoring season, 26,116 cells (21.1%) had at least one ASMAP plant while 97,372 (78.9%) had no ASMAP. Among the management areas, Gecko had the highest occupancy rate with thirty percent of cells occupied, followed by the Wilderness (29.2%), Mammoth Wash (28.4%), AMA (24.6%), Ogilby (13.4%), Glamis (11.0%), and Buttercup (5.6%) (see Table 1).

Among all seven management areas, there were 70,131 (56.8% of total) cells surveyed that were closed to OHV activity. No cells were closed to OHV activity in the Buttercup Management Area while all cells in the Wilderness and AMA were closed. Four

management areas included cells open to OHV activity as well as cells closed to OHV activity. Of these, Gecko had the highest percentage (62.7%) of occupied cells closed to OHV activity followed by Mammoth Wash (52.7%), Ogilby (31.0%) and Glamis (24.5%). Seventy-four point six percent of the entire observed population occurred in cells that were closed to OHV activity. Of the mixed use management areas, Gecko had the highest proportion of its ASMAP population in cells closed to OHV activity (70.0%), followed by Ogilby (51.5%), Mammoth Wash (51.4%) and Glamis (28.4%) (see Table 1).

There were 739,805 plants observed during the 2005 surveys. Half of this population occurred in 3.6 percent of occupied cells (0.7% of total cells). The temporary closures accounted for 66% of the observed population. The median number of occupied cells had eight or fewer plants per cell. By management area, the total number of plants found and the percentage of occupied cells that contained half of that total is: for the AMA 305,586 individuals and 4.6% of occupied cells; for Ogilby 219,153 individuals and 3.7% of the occupied cells; for Gecko 66,081 individuals and 7.8% of the occupied cells; for the Wilderness 63,505 individuals and 6.8% of the occupied cells; for Mammoth Wash 36,877 and 8.4% of the occupied cells; and for Buttercup 31,779 individuals and 4.6% of the occupied cells. Glamis had the lowest observed population with 16,797 observed plants, half of which occurred in 7.6% of occupied cells (see Table 2).

Mean nearest neighbor distances were calculated between cells within the same abundance class. By abundance class, class 1 cells with few ASMAP plants were weakly clustered throughout the dunes with a mean nearest neighbor distance of 34 meters. As the number of plants per cell increase, the mean nearest neighbor distance increases to a maximum 275 meters for class 6. Class 7 cells with the highest numbers of observed plants per cell were highly clustered throughout the dunes, with a mean nearest neighbor distance of 211 meters. Cells devoid of ASMAP (class 0) were almost evenly distributed between the open and closed areas with 52.2% of unoccupied cells in closed areas, and more randomly distributed throughout the dunes (see Table 3).

The Chi-square ASMAP occupancy analysis of cells open and closed to OHV activity was perhaps the most revealing. Sampling 5% of cells reported a Chi-square value = 204 ($p < 0.0001$). Fisher's Exact Test reported $p < 0.0001$. The odds of finding ASMAP in cells closed to OHV activity was 2.63 times greater than finding a plant in the open area (95% confidence interval = 2.280 – 2.997). Sampling 1% of cells resulted in similar findings with a reported Chi-square value = 34. Fisher's Exact Test for the 1% sample reported $p < 0.0001$, with odds 2.42 times greater of finding ASMAP in closed areas (95% confidence interval = 1.769 - 3.330) than in the area open to OHV activity.

Similar results were reported for both seedlings and plants more than one year old. A 5% sample for seedlings dunes-wide reported a Chi-square value = 60 ($p < 0.0001$), with the

odds of finding seedling ASMAP in closed areas 1.94 (95% confidence interval = 1.63 – 2.31) times greater than open areas. The 5% sample for plants older than one year reported a Chi-square value = 21 (p < 0.0001) with odds of finding older ASMAP in closed areas 2.41 (95% confidence interval = 1.62 – 3.64) times greater than in open areas.

We conducted the same plant occupancy Chi-square analysis for the Gecko Management Area. Sampling 10% of cells, every 17th and 21st record, resulted in a Chi-square value = 41 (p < 0.0001). The odds of finding ASMAP in the closed areas of Gecko was 2.23 (95% confidence interval = 1.731 – 2.883) times greater than finding it in the open area. Seventy percent of the observed population of Gecko occurred in areas closed to OHV activity.

We ran a Chi-square bootstrap analysis for the entire dunes, running 1,000 iterations of a 1,000-cell sample. The odds of finding ASMAP in an area closed to OHV activity was 2.61 time greater than finding it in areas open to OHV activity (95% confidence interval = 1.87 – 3.67). We compared the Gecko and Ogilby mixed-use management areas using the same bootstrap. In Gecko, the odds of finding ASMAP in the OHV-closed area was 2.5 time greater than the open area (95% confidence interval = 1.96 – 3.31), whereas in Ogilby the odds of finding ASMAP in the OHV-closed area was 6.31 times greater (95% confidence interval = 2.29 – 25.8) (see Table 5).

Abundance classes across the entire dunes differed by closure status, with more cells of all classes being more frequently encountered in areas closed to OHV activity. With very few cells in each of the higher abundance classes, classes 4 through 7 were combined in order to increase the size of the observed sample for the analysis. Sampling 5% of cells reported a Chi-square = 256 (p < 0.0001) (see Table 4), indicating that closed areas may be refugia for large concentrations of ASMAP (see Table 3).

Discussion

The 2005 monitoring was the most extensive survey for Peirson's milk-vetch to date. Well-timed precipitation events from October 2004 through March 2005 resulted in the largest apparent expression of the milk-vetch population yet recorded. Based on our additional analysis of the BLM 2005 monitoring database identifying cells as to whether they were open or closed to OHV activity, even with favorable conditions for germination and reproduction, ASMAP plants occured in only 21% of the cells sampled throughout the dunes, with approximately 75% of the observed population occurring in areas recently or permanently closed to OHV activity. Calculated dunes-wide plant density was about 126 plants/hectare for areas closed to OHV activity compared to 56 plants/hectare for areas open to OHV activity.

Of the four management areas both open and closed to OHV activity, three had two-thirds or better of their observed population within areas closed to OHV activity. Glamis, with 17.9% of surveyed cells within areas closed to OHV activity, had 28.4% of its

observed population within those closed areas. This small area, and the geographic position of Glamis on the eastern edge of ASMAP concentrations, likely contributed to this low proportion.

In the Gecko Management Area, 46.9% of the sampled area occurred within the temporary closures. Yet 70% of the observed population occurred in these closures. In Ogilby, only 11.9% of the sampled area occurred within the temporary closure. But slightly over half (51.5%) of the observed population was located in cells in the temporary closure, yielding an astounding 569 plants/hectare compared to 72.4 plants/hectare in the open area of Ogilby. Ranking Ogilby as the management area with the highest density in the 2005 monitoring report was apparently achieved by the inclusion of the cells in the small temporary closure. Ranking Gecko equal to the Wilderness Management Area may also be due to the closures, otherwise its density may better resemble that of Glamis. All of this information indicates that areas closed to OHV activity were important contributors to the overall milk-vetch population. This is compounded by the fact that 74% of the cells occupied by ASMAP were in the areas closed to OHV activity, accounting for 74.6% of the observed population. All life stages of ASMAP, from seedling to reproducing, were about two times or better more likely to occur in areas closed to OHV activity.

In general, ASMAP is very sparsely distributed throughout ISDRA. Only 21% of the area was occupied by ASMAP and half the sampled cells occupied by ASMAP had 8 or fewer plants per cell. But ASMAP does occur in higher concentrations. Half the total observed population occurred in approximately 0.7% of all cells sampled (3.6% of occupied cells) indicating that a very large portion of the population occurred within highly clustered areas. The temporary closures apparently serve as refugia for ASMAP with the odds of finding ASMAP in closed areas better than twice as likely than open areas. Sixty-six percent of the observed ASMAP population in 2005 occurred within the temporary closures.

Table 1: Cells occupied with ASMAP by management area.

Management Area (MA)	Total # cells surveyed	# surveyed cells occupied by ASMAP	% total surveyed cells occupied by ASMAP in MA	% of total occupied cells open to OHV activity in MA	% of total occupied cells closed to OHV activity in MA	percent occupied cells in MA open to OHV activity	percent occupied cells in MA closed to OHV activity
Mammoth Wash	10,680	3,038	28.4	5.5	6.1	47.3	52.7
Wilderness	13,829	4,037	29.2	0.0	15.6	0.0	100.0
Gecko	13,037	3,911	30.0	5.6	9.4	37.3	62.7
Glamis	12,450	1,372	11.0	4.0	1.3	75.5	24.5
AMA	39,795	9,798	24.6	0.0	37.5	0.0	100.0
Ogilby	26,574	3,563	13.4	9.4	4.2	69.0	31.0
Buttercup	7,110	392	5.6	1.5	0.0	100.0	0.0
Entire Dunes	123,488	26,116	21.1			26.0	74.0

Table 2. Observed population and cell occupancy.

Management Area (MA)	Observed Population	% total observed pop.	% occupied cells below median pop.	% occupied cells above median pop.	# plants/cell below median cell number	% MA population in cells open to OHV activity	% MA population in cells closed to OHV activity
Mammoth Wash	36,877	5.0	91.6	8.4	4	48.6	51.4
Wilderness	63,505	8.6	93.2	6.8	5	0.0	100.0
Gecko	66,081	8.9	92.2	7.8	5	30.0	70.0
Glamis	16,797	2.3	92.4	7.6	4	71.6	28.4
AMA	305,586	41.3	95.8	4.2	6	0.0	100.0
Ogilby	219,153	29.6	96.3	3.7	8	48.5	51.5
Buttercup	31,779	4.3	95.4	4.6	8	100.0	0.0
Entire Dunes	739,805	100.0	96.4	3.6	6	25.4	74.6
Closed Areas	551,978	74.6	96.2	3.8	6		

Table 3. Occupied cell mean nearest neighbor distance (meters) and abundance by class.

Abundance Class	# Cells	Mean Nearest Neighbor (meters)	Expected Nearest Neighbor (meters)	Ratio	% cells closed to OHV activity	% Total Observed Population	% Total Observed Pop. Closed to OHV	% Total Observed Pop. Open to OHV
0	97,372	26	74	0.3471	52.2	0.0	0.0	0.0
1	22,093	34	153	0.2232	74.4	23.9	18.6	5.3
2	1,981	101	504	0.2014	73.3	13.6	10.6	3.0
3	790	161	789	0.2050	71.4	9.7	7.5	2.2
4	465	209	1027	0.2035	69.9	9.1	6.6	2.5
5	312	238	1256	0.1899	68.9	8.9	6.3	2.6
6	249	275	1395	0.1971	67.1	11.4	7.8	3.6
7	221	211	1476	0.1429	74.2	23.3	17.2	6.1
						99.9	74.6	25.3

Table 4. Results of Chi-square analysis of abundance classes.

results	5%		numbers: 31, 51, random start			

count class

observed	0	1	2	3	4+	sum
open	2604	108	8	4	6	2730
closed	2953	555	44	20	25	3597
sum	5557	663	52	24	31	6327

Expected	0	1	2	3	4+
open	2397.757	286.1	22.44	10.36	13.38
closed	3159.243	376.9	29.56	13.64	17.62
sum	5557	663	52	24	31

X^2	0	1	2	3	4+
open	17.73994	110.8	9.29	3.901	4.067
closed	13.46401	84.13	7.05	2.96	3.087

$X^{2\ total}$	256.535

Table 5. Results of Chi-square bootstrap analysis of ASMAP presence.

	Mean	Median	97.5% LCI	97.5% UCI
Entire Dunes	2.58184	2.60831	1.87439	3.66767
Gecko MA	2.50297	2.52671	1.96023	3.3185
Obilby MA	6.30565	7.57895	2.29107	25.8038